

AMENDMENTS TO THE CLAIMS

This listing of claims replaces all prior listing of claims for the present application.

Claims 1-123 (Canceled).

124. (Withdrawn) A method of sensing photons comprising:

receiving said photons into a trench, said trench disposed in a doped layer of a first conductivity type formed in a semiconductor substrate;

activating a diode formed in said substrate adjacent said trench by absorbing said photons, said diode including a first doped region of a second conductivity type formed in a sidewall and bottom of said trench;

receiving charges from said first doped region into a second doped region of said second conductivity type formed in said doped layer; and

resetting a charge level of said second doped region by receiving charges from said second doped region into a conductive signal line .

125. (Withdrawn) A method of sensing photons as defined in claim 124 wherein said resetting a charge level of said second doped region comprises transferring charges through a reset transistor.

126. (Withdrawn) A method of sensing photons as defined in claim 125 wherein said reset transistor includes a drain region and a gate and wherein said second doped region includes a source of said reset transistor.

127. (Withdrawn) A method of sensing photons as defined in claim 124 wherein receiving said photons into said trench comprises receiving said photons through an aperture in an upper surface of said semiconductor substrate.

128. (Withdrawn) A method of sensing photons as defined in claim 124 wherein activating said diode comprises energizing electrons in response to absorbing said photons into said semiconductor substrate.

129. (Withdrawn) A method of sensing photons as defined in claim 124 wherein activating said diode comprises absorbing said photons in a first region of a surface of said trench after reflecting said photons from a second region of said surface of said trench.

130. (Withdrawn) A method of sensing photons as defined in claim 124 wherein activating said diode comprises:

conducting said photons through a transparent layer disposed above an internal surface of said trench; and

absorbing said photons into said semiconductor substrate.

131. (Withdrawn) A method of sensing light comprising:

receiving said light through an aperture in a surface of a semiconductor substrate;

absorbing said light into an internal surface of said semiconductor substrate, said internal surface defining a cavity within said semiconductor substrate;

energizing an electron of said semiconductor substrate with said absorbed light; and

activating a switching device using said energized electron.

132. (Withdrawn) A method of sensing light as defined in claim 131 wherein said activating a switching device comprises activating a field effect transistor.

133. (Withdrawn) A method of sensing light as defined in claim 131 wherein said absorbing said light into said internal surface comprises receiving said light into said substrate through a layer of conductive material.

134. (Withdrawn) A method of sensing light as defined in claim 133 wherein said layer of conductive material comprises a photo-gate said method including applying an electrical potential to said photo-gate.

135. (Withdrawn) A method of sensing light as defined in claim 131 wherein said absorbing said light into said internal surface comprises receiving said light into said substrate through a layer of insulating material.

136. (Withdrawn) A method of sensing light as defined in claim 131 wherein said absorbing said light into said internal surface comprises receiving said light through a first region of substrate material having a first doping characteristic into a second region of substrate material having a second doping characteristic.

137. (Withdrawn) A method of sensing light as defined in claim 131 wherein said switching device includes a field effect transistor and wherein said activating a switching device using said energized electron comprises:

passing said energized electron through a first transistor to a floating diffusion region; and

elevating an electrical potential of a gate of said field effect transistor, said gate being electrically coupled to said floating diffusion region.

Claims 138-169 (Canceled).

170. (Withdrawn) A method of converting an optical signal to an electrical signal comprising:

receiving said optical signal at a surface of a photoreceptor;

absorbing said optical signal through said surface of said photoreceptor;

energizing a plurality of electrons with said optical signal in relation to an intensity of said optical signal;

storing said plurality of energized electrons in a substantially concave distribution within a substrate and thereby adjusting an electrical potential of a corresponding substantially concave region within said substrate, said substrate supporting said photoreceptor; and

adjusting an electrical output signal of an output circuit in relation to a magnitude of said electrical potential.

171. (Withdrawn) A method of converting an optical signal to an electrical signal as defined in claim 170 wherein said substantially concave region within said substrate comprises a region disposed about a surface of a cavity within said substrate.

172. (Withdrawn) A method of converting an optical signal to an electrical signal as defined in claim 171 wherein said surface of said cavity comprises a substantially cylindrical surface.

173. (Withdrawn) A method of converting an optical signature to an electric signal as defined in claim 171 wherein said surface of said cavity comprises a substantially rectangular surface.

174. (Withdrawn) A method of converting an optical signal to an electrical signal as defined in claim 171 wherein said surface of said photoreceptor and said surface of said cavity are substantially coextensive.

175. (Withdrawn) A method of converting an optical signal to an electrical signal as defined in claim 171 wherein said substrate includes a further doped region adjacent to said internal surface of said cavity, said substantially concave region being disposed adjacent said further doped region such that said further doped region is located between said substantially concave region and said surface of said cavity.

176. (Withdrawn) A method of converting an optical signal to an electrical signal as defined in claim 170 further comprising:

receiving said electrical potential at a gate of a transistor disposed within said output circuit; and

receiving said electrical output signal through said transistor at an output node of said output circuit.

177. (Withdrawn) A method of converting an optical signal to an electrical signal as defined in claim 176 wherein receiving said electrical output signal through said transistor includes receiving an analog current signal, said method further comprising:

receiving said analog current signal at an input of an analog to digital converter and;

converting said analog current signal to a digital signal in said analog to digital converter.

178. (Withdrawn) A method of converting an optical signal to an electrical signal as defined in claim 177 wherein said converting said analog current signal to a digital signal in said analog to digital converter comprises:

receiving said analog current signal at an input of a sample and hold circuit;

sampling said analog current signal; and

digitizing said analog current signal to produce a digital output signal.

179. (Withdrawn) A method of converting an optical signal to an electrical signal as defined in claim 178 further comprising:

storing said digital output signal in a digital electronic memory.

180. (Withdrawn) A method of converting an optical signal to an electrical signal as defined in claim 179 wherein said photoreceptor, said analog to digital converter, and said digital electronic memory are all disposed on said substrate.

181. (Withdrawn) A method of converting an optical signal to an electrical signal as defined in claim 170 wherein said adjusting said output electrical signal of an output circuit comprises receiving a plurality of said energized electrons at a floating diffusion node disposed within said substrate from said concave region.

182. (Withdrawn) A method of converting an optical signal to an electrical signal as defined in claim 181 wherein said receiving said plurality of energized electrons at said floating diffusion node from said substantially concave region comprises:

receiving said plurality of energized electrons at said floating diffusion node through a transfer gate region of said substrate; and

controlling a conductivity of said transfer gate region of said substrate by adjusting an electrical potential of a conductive transfer gate disposed above said transfer gate region of said substrate.

183. (Withdrawn) A method of converting an optical signal to an electrical signal as defined in claim 181 further comprising:

resetting an electrical potential of said floating diffusion node by switchingly coupling said floating diffusion node to a source of substantially constant electrical potential.

184. (Withdrawn) A method of converting an optical signal to an electrical signal as defined in claim 170 wherein said receiving said optical signal comprises receiving an electromagnetic signal including visible spectrum light.

185. (Withdrawn) A method of converting an optical signal to an electrical signal as defined in claim 170 wherein said absorbing said optical signal through said surface of said photoreceptor comprises absorbing said optical signal through a layer of insulating material disposed above a surface of said substrate.

186. (Withdrawn) A method of converting an optical signal to an electrical signal as defined in claim 170 wherein said absorbing said optical signal through said surface of said photoreceptor comprises absorbing said optical signal through a layer of conductive material disposed above a surface of said substrate.

187. (Withdrawn) A method of converting an optical signal to an electrical signal as defined in claim 186 wherein said layer of conductive material comprises a metallic material.

188. (Withdrawn) A method of converting an optical signal to an electrical signal as defined in claim 186 wherein said layer of conductive material comprises a photo-gate.

Claims 189-198 (Canceled).

200. (Currently amended) A method of forming a ~~photo-sensor~~ photosensor comprising:

excavating a trench within a semiconductor substrate, said trench having a substantially vertical internal surface region;

performing a first ion implantation into said substantially vertical internal surface region at a first ion implantation angle;

performing a second ion implantation into said substantially vertical internal surface region at a second ion implantation angle.

201. (Currently amended) A method of forming a photosensor as defined in claim [[199]] 200, wherein said first implantation angle is orthogonal to said second ion implantation angle.

202. (Currently amended) A method of forming a photosensor as defined in claim [[199]] 200 further comprising[[::]] performing a further plurality of ion implantations at a respective plurality of ion implantation angles.

203. (Currently amended) A method of forming a photosensor as defined in claim [[199]] 200 further comprising applying a passivation layer above said substantially vertical internal surface region.

204. (Original) A method of forming a photosensor as defined in claim 203 wherein said passivation layer comprises silicon dioxide.

205. (Original) A method of forming a photosensor as defined in claim 203 wherein said passivation layer comprises Borosilicate glass.

206. (Original) A method of forming a photosensor as defined in claim 203 wherein said passivation layer comprises phospho-silicate glass.

207. (Original) A method of forming a photosensor as defined in claim 203 wherein said passivation layer comprises boron-phospho-silicate glass.

208. (Original) A method of forming a photosensor as defined in claim 203 further comprising chemical mechanical planarizing said passivation layer.

209. (Currently amended) A method of forming a photosensor as defined in claim [[199]] 200, wherein said step of excavating a trench further comprises anisotropically etching said semiconductor substrate.